



Update of CH₄ retrieval from AIRS(v6), IASI and CrIS

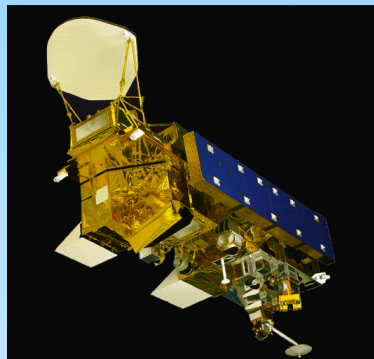
Xiaozhen(Shawn) Xiong, Chris Barnet
Eric Maddy, Antonia Gambacorta, Thomas S. King



NASA Sounder Science Team Meeting
Nov. 13-16, 2012, Greenbelt, Maryland



(A plan to derive CH₄ and other GHG data of 20+ years)

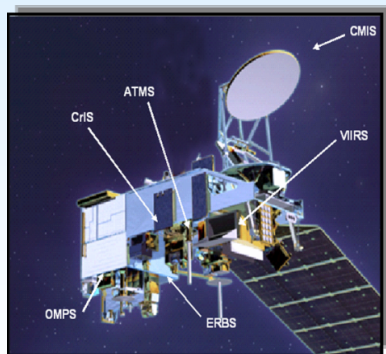


AIRS on NASA/Aqua 1:30 pm orbit (May 4, 2002)

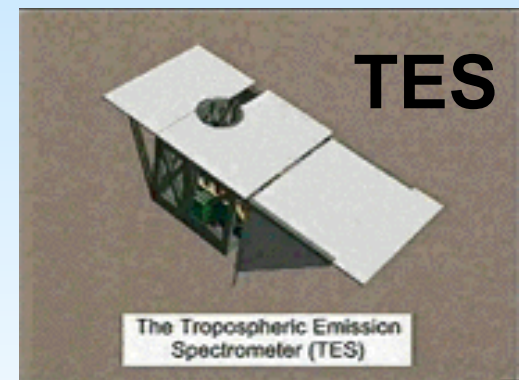


IASI on METOP-A(Oct. 19, 2006) METOP-B(Sept 27,2012) 9:30 am orbit

→ comparison



CrIS on NPP 1:30 pm orbit (Oct.28,2011) and JPSS



Outline

- **Summary of AIRS-V6 CH₄ as compared to V5;**
- **Validation of IASI CH₄ and its improvement;**
- **Current status of CH₄ retrieval from CrIS on Soumi NPP.**

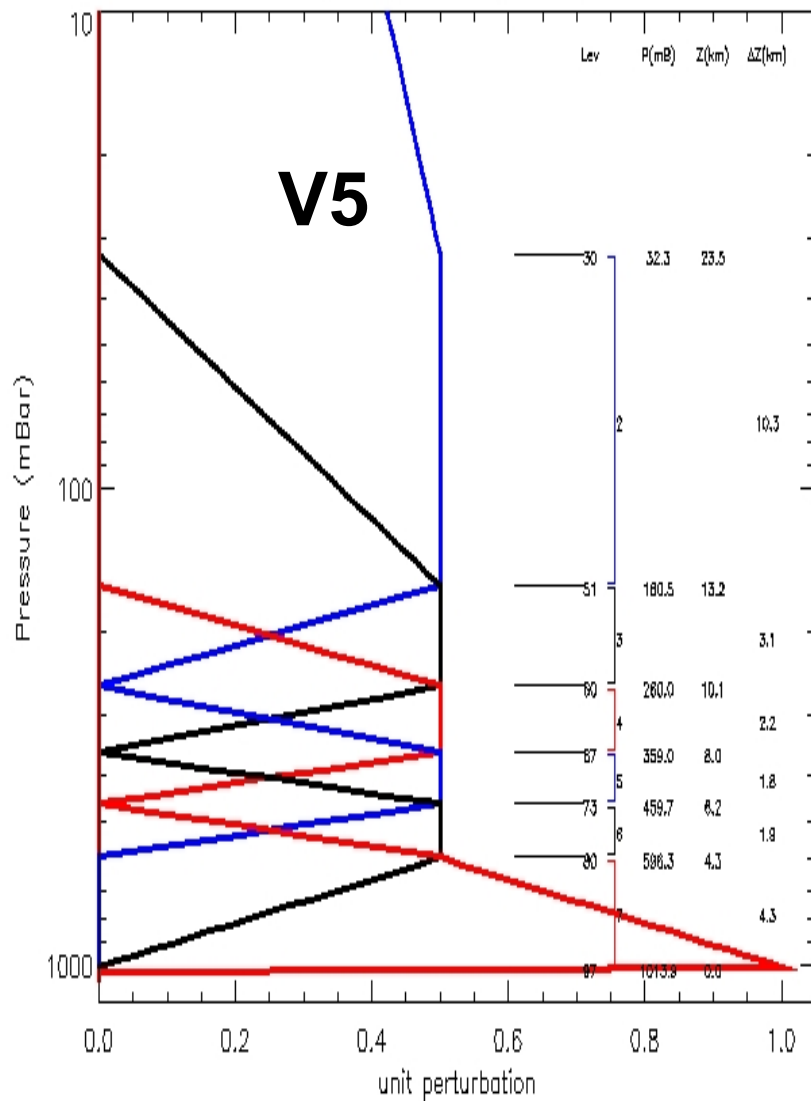
- **Some comparison of CH₄**
 1. **Among CrIS, IASI and AIRS-v6 (5/15/2012);**
 2. **Seasonal cycle of CH₄ over South Asia and Siberia from AIRS-v5 (10 yrs) and IASI (5 yrs);**
 3. **AIRS-v6 vs GOSAT TIR CH₄;**

- **One major effort to derive a better CH₄ product in the polar region**

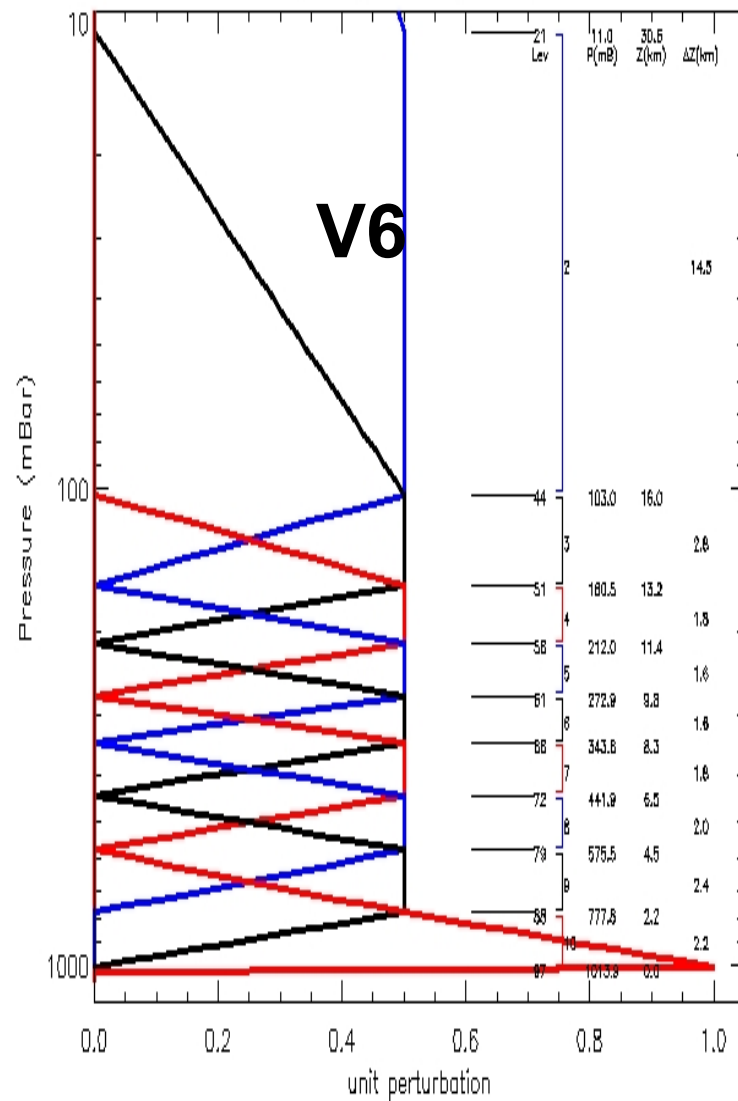
- **Summary**

More Retrieval Layers

CH₄ Retrieval Functions

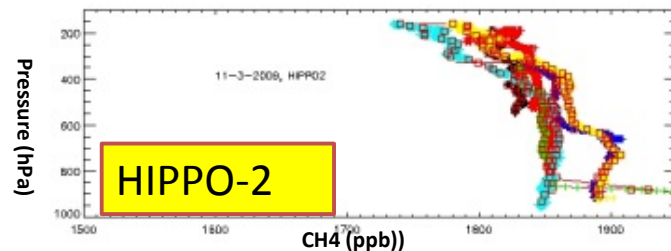
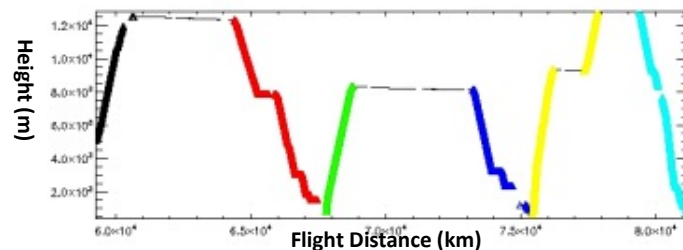
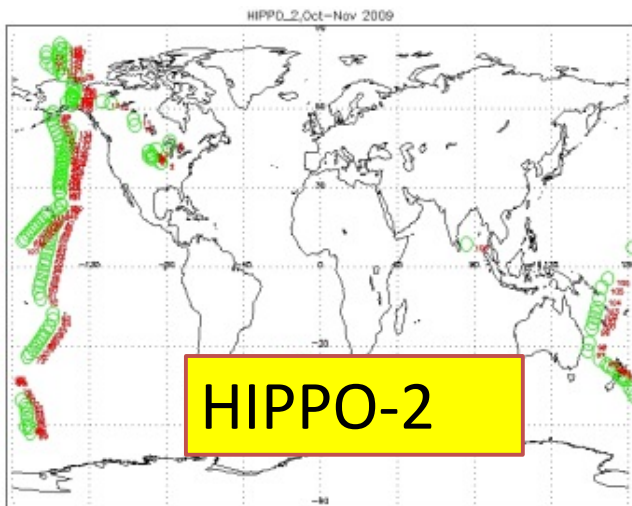
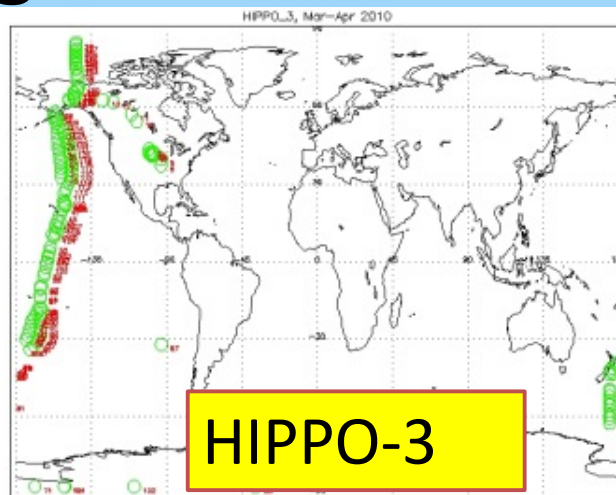
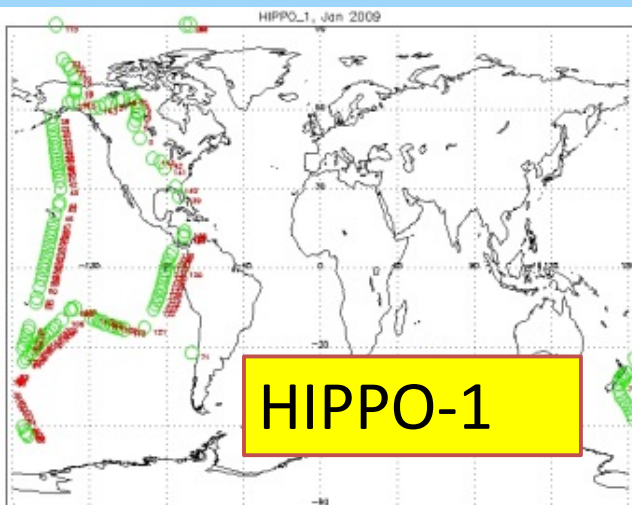


CH₄ Retrieval Functions





Backup of aircraft measurement for tuning and Validation

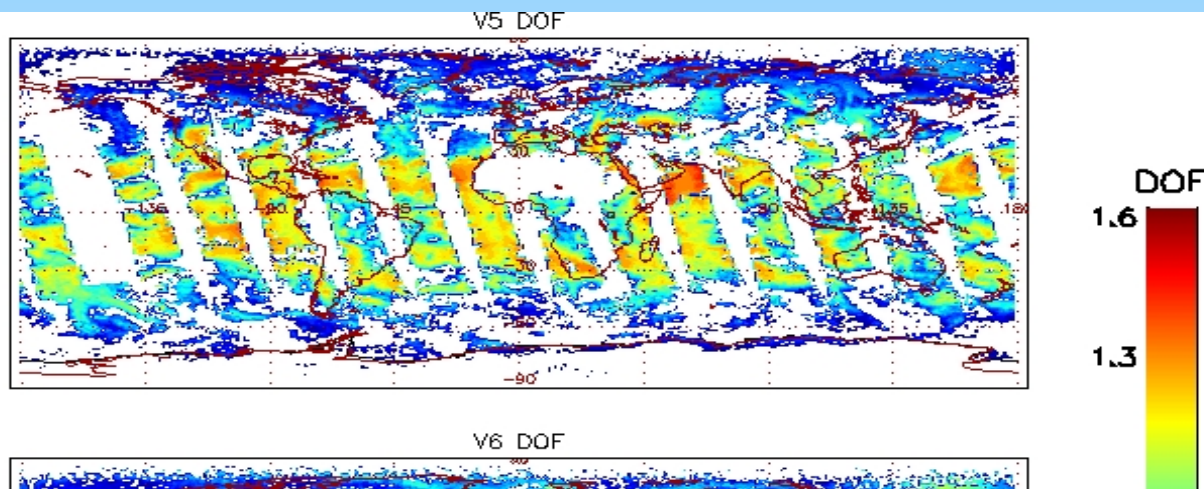


HIPPO -1 (Jan 2009) ; HIPPO -2 (Oct/11, 2009); HIPPO-3 (March/April, 2010) (HIAPER Pole-to-Pole Observations of Carbon Cycle Greenhouse Gases study)

Optimization of CH₄ retrieval in V6

| | V5 (Research Product) | V6 (Standard product) |
|------------------|-----------------------|--------------------------|
| Retrieval layers | 7 | 10 |
| Channel s | 71 | 58 |
| First guess | | updated |
| Quality Flag | | well set |
| tuning | empirical | Using more aircraft data |

AIRS V5 vs V6 (March 27,2010)



- V6-CH4 has improved QC;
- V6-CH4 has larger DOF than V5;
- V6-CH4 has a better sensitivity lower troposphere;
- Small bias and RMS error

343-496 hPa(pge52bin) hippo

$R = 0.87(0.92)$

$N = 103$

Bias = $-0.21(-1.13)\%$

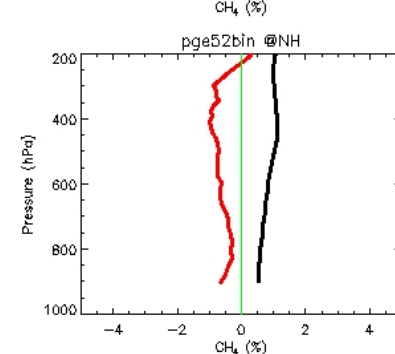
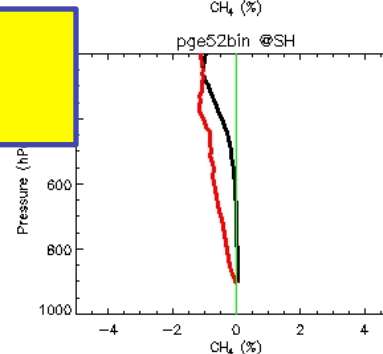
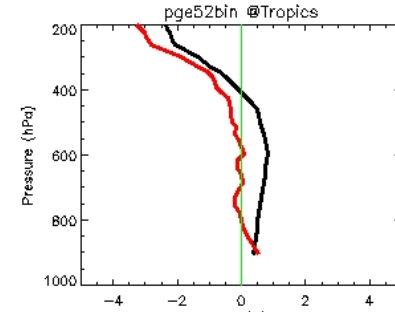
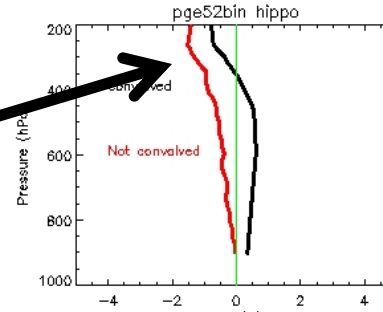
rms = $1.31(1.47)\%$

Convolved with AK

Truth

?

V5



343-496 hPa(v82antbin) hippo

$R = 0.91(0.88)$

$N = 104$

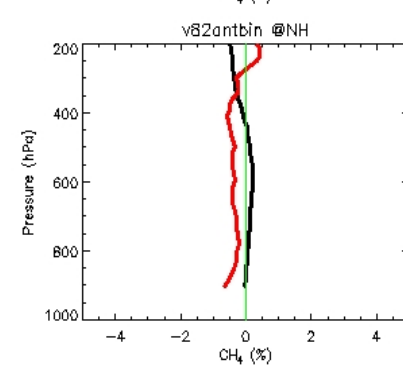
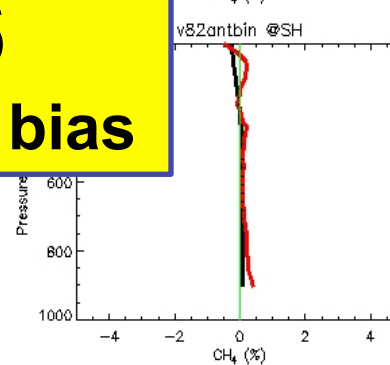
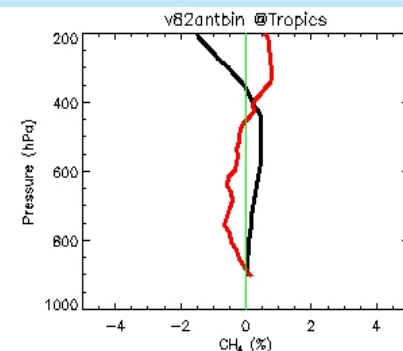
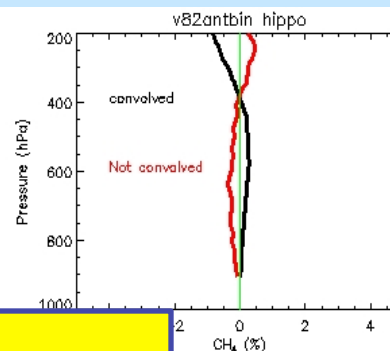
Bias = $-0.26(0.200)\%$

rms = $1.02(1.17)\%$

Convolved with AK

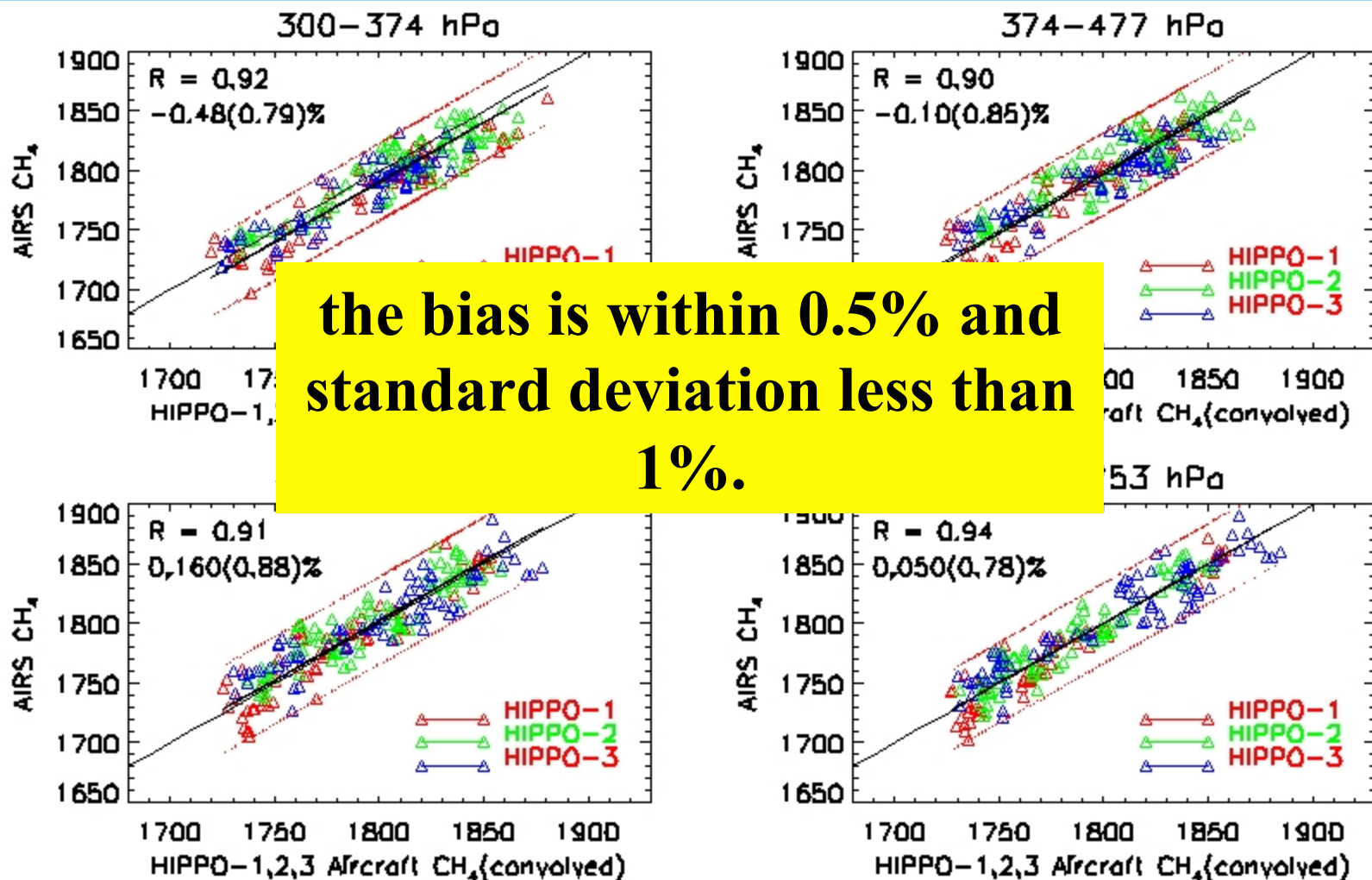
Truth

V6
Smaller bias





Scatter plot of AIRS vs In-situ

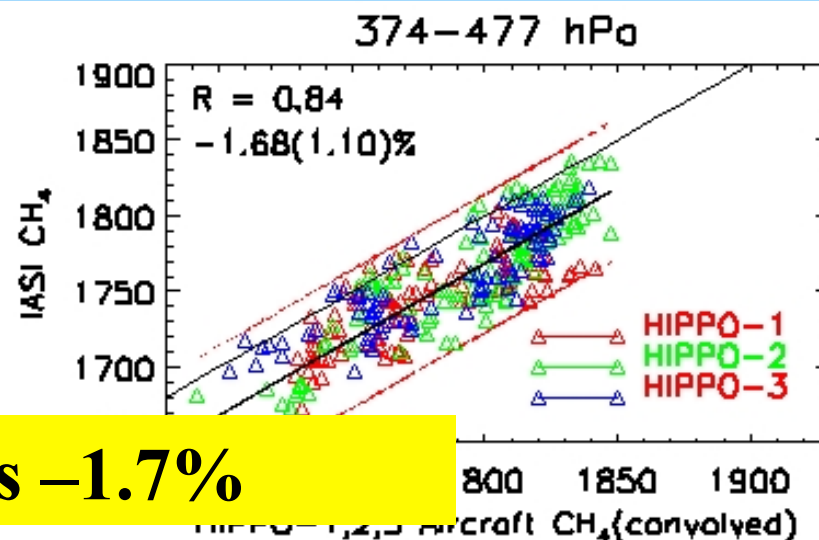
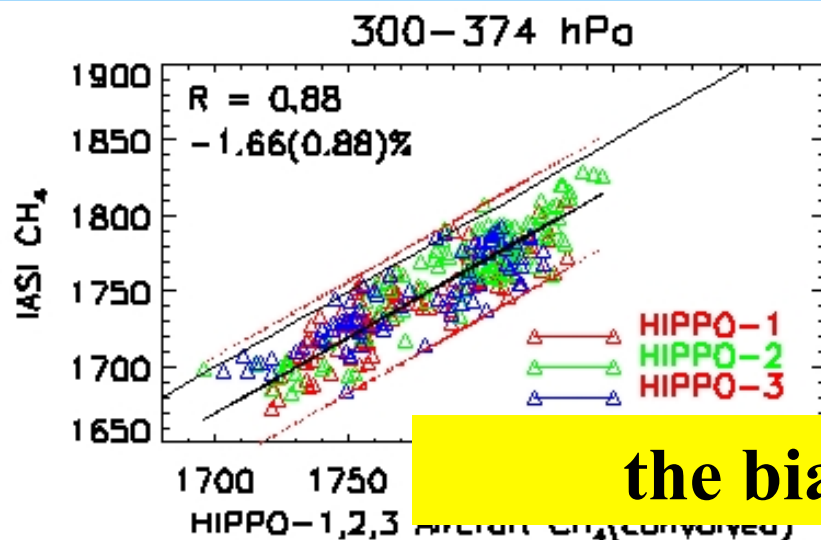




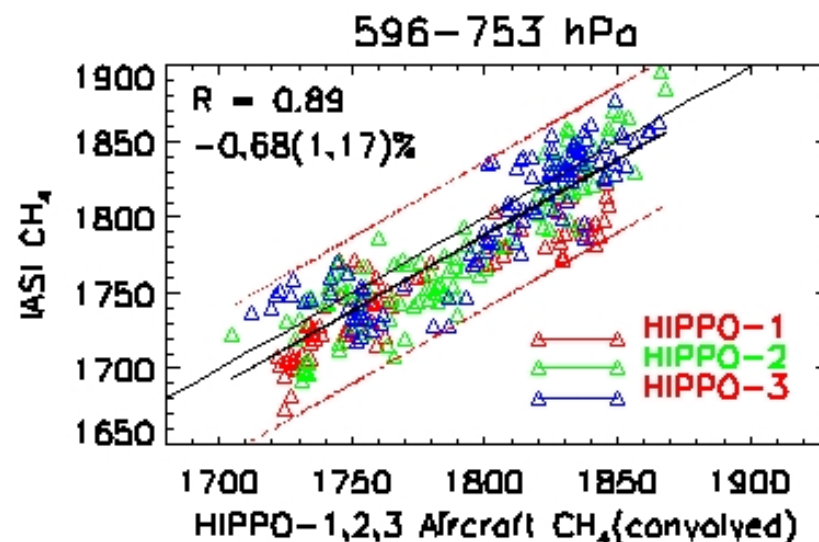
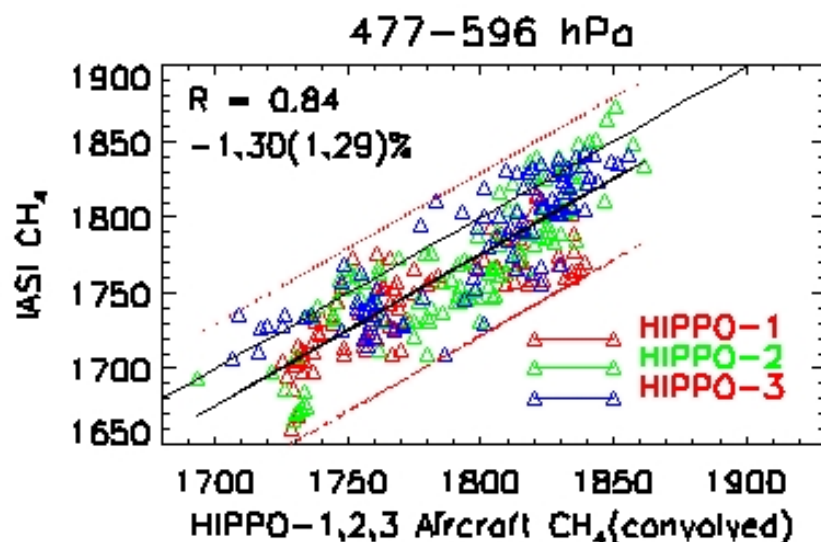
IASI CH4 Validation and Improvement

- **New Quality control is recommended**
 - **Recent Validation**
 - **Improvements by adopting the improvement in AIRS-v6**
-
- a paper is submitted to Atmos. Meas. Tech.**

Scatter plot of IASI vs In-situ CH₄

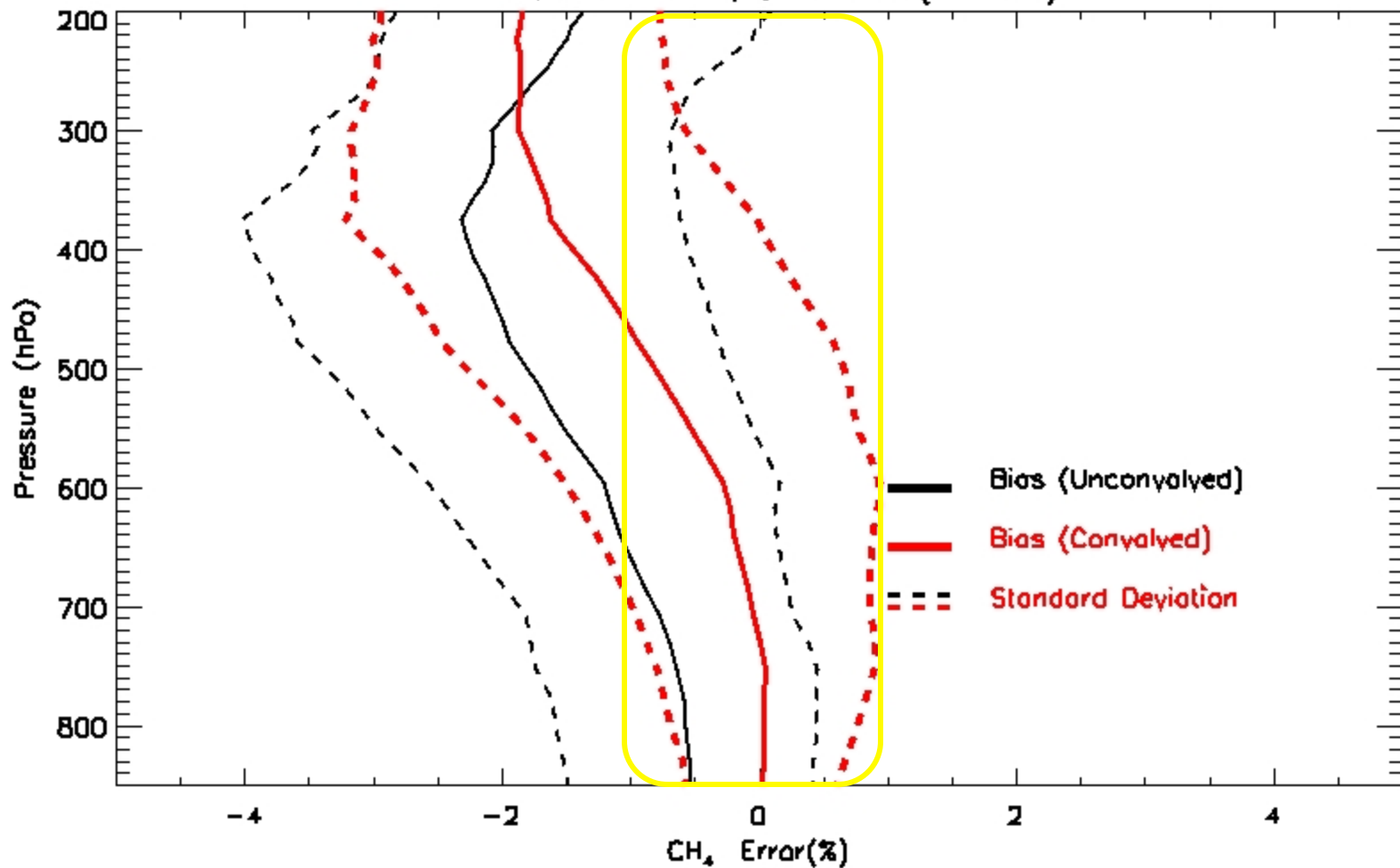


the bias is -1.7%



Error of IASI CH₄

IASI vs HIPPO-1,2,3 In Situ (N=327)



IASI CH₄ have been generated on NOAA CLASS system;



CH₄ retrieval from CrIS on Soumi NPP

on *NOAA Unique CrIS ATMS Processing System (NUCAPS)*

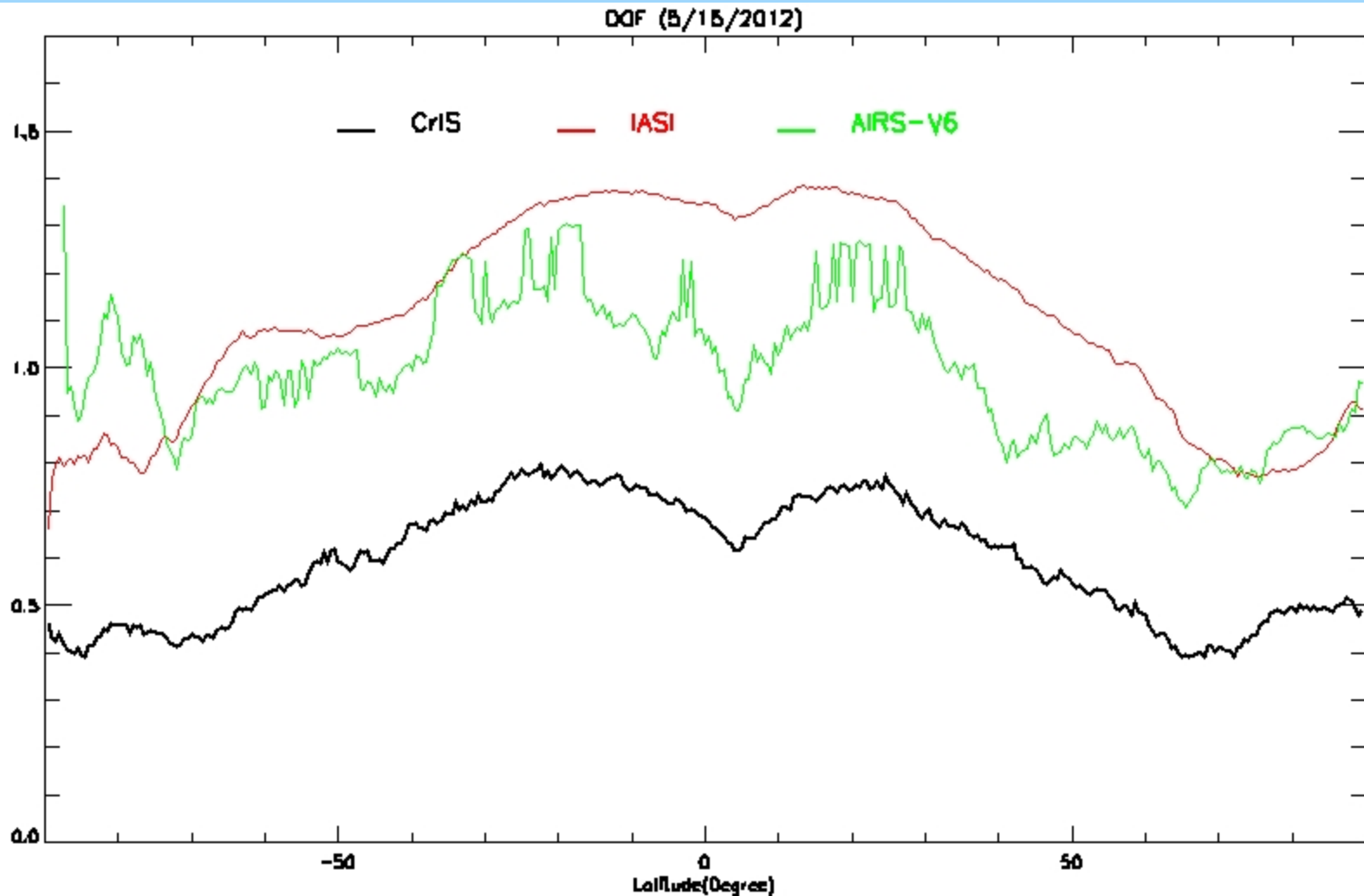
(more detail see Antonia's talk tomorrow)

**Comparison of CH₄ from AIRS, IASI and
CrIS using data on 5/15/2012**



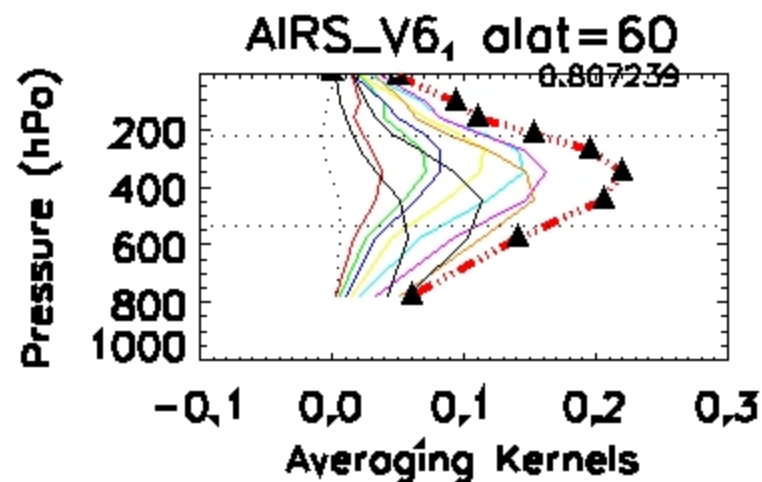
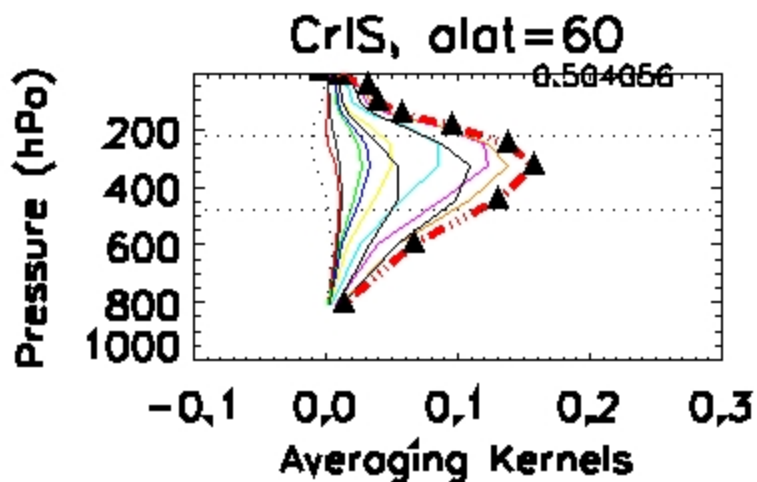
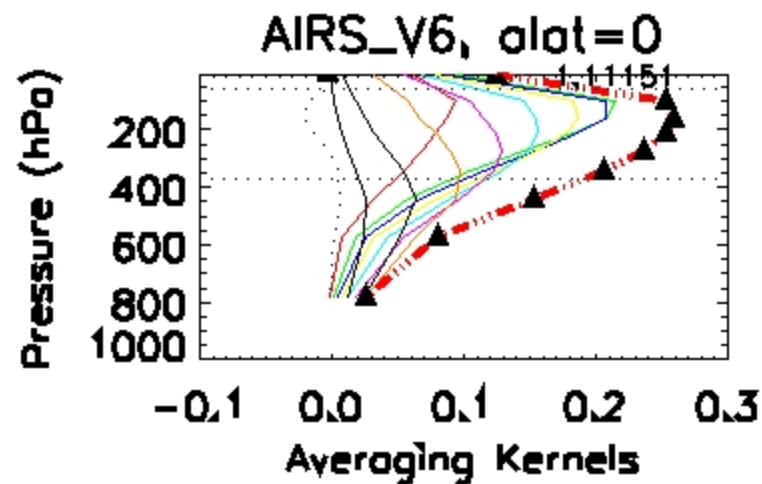
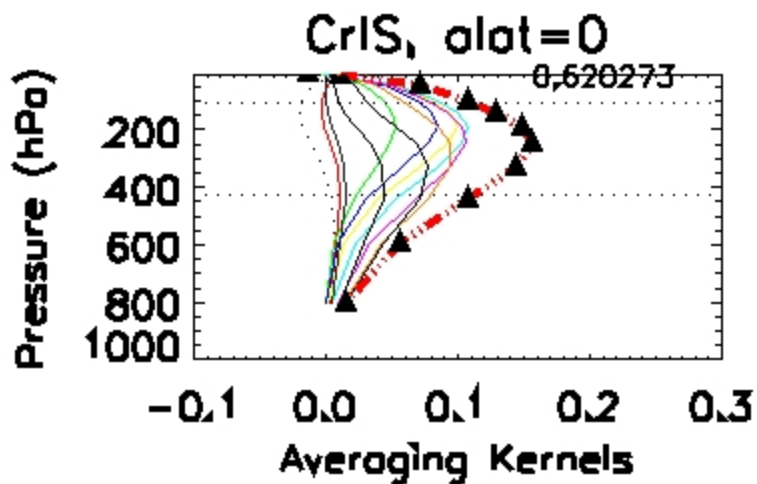
Comparison of DOF in different latitude

5/25/2012



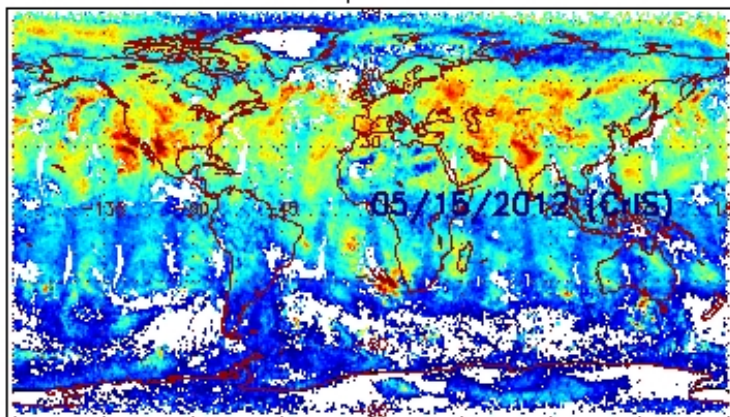
Comparison of Averaging Kernels

5/15/2012

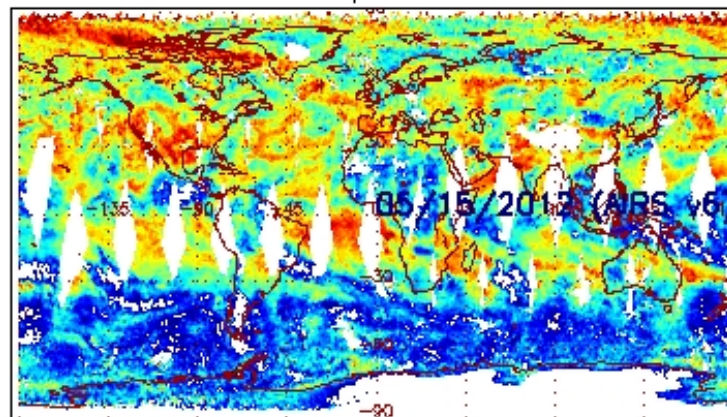


Comparison of CH₄ at 400 hPa from CrIS, AIRS, IASI (5/15/2012)

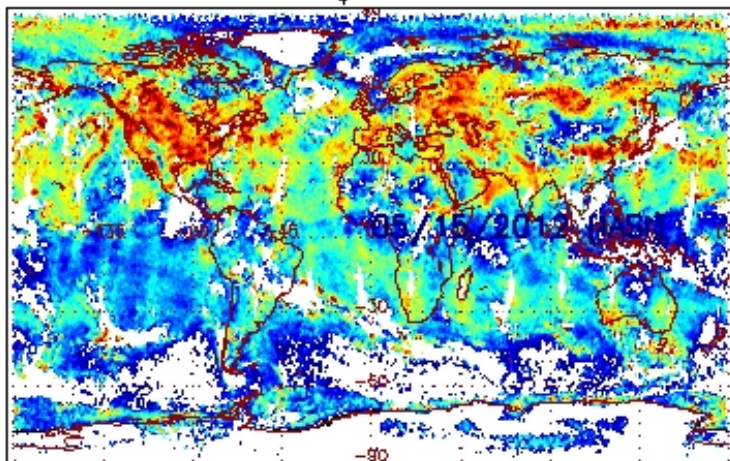
CrIS CH₄ at 407hPa



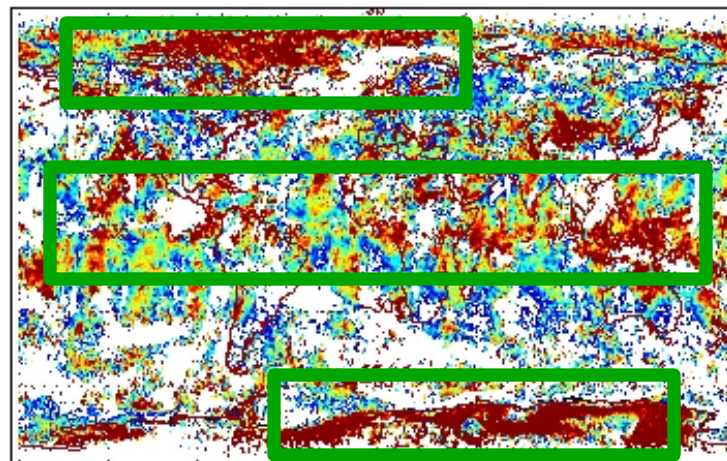
AIRS CH₄ at 407hPa



IASI CH₄ at 407hPa



CrIS-AIRS CH₄ @407hPa



1750

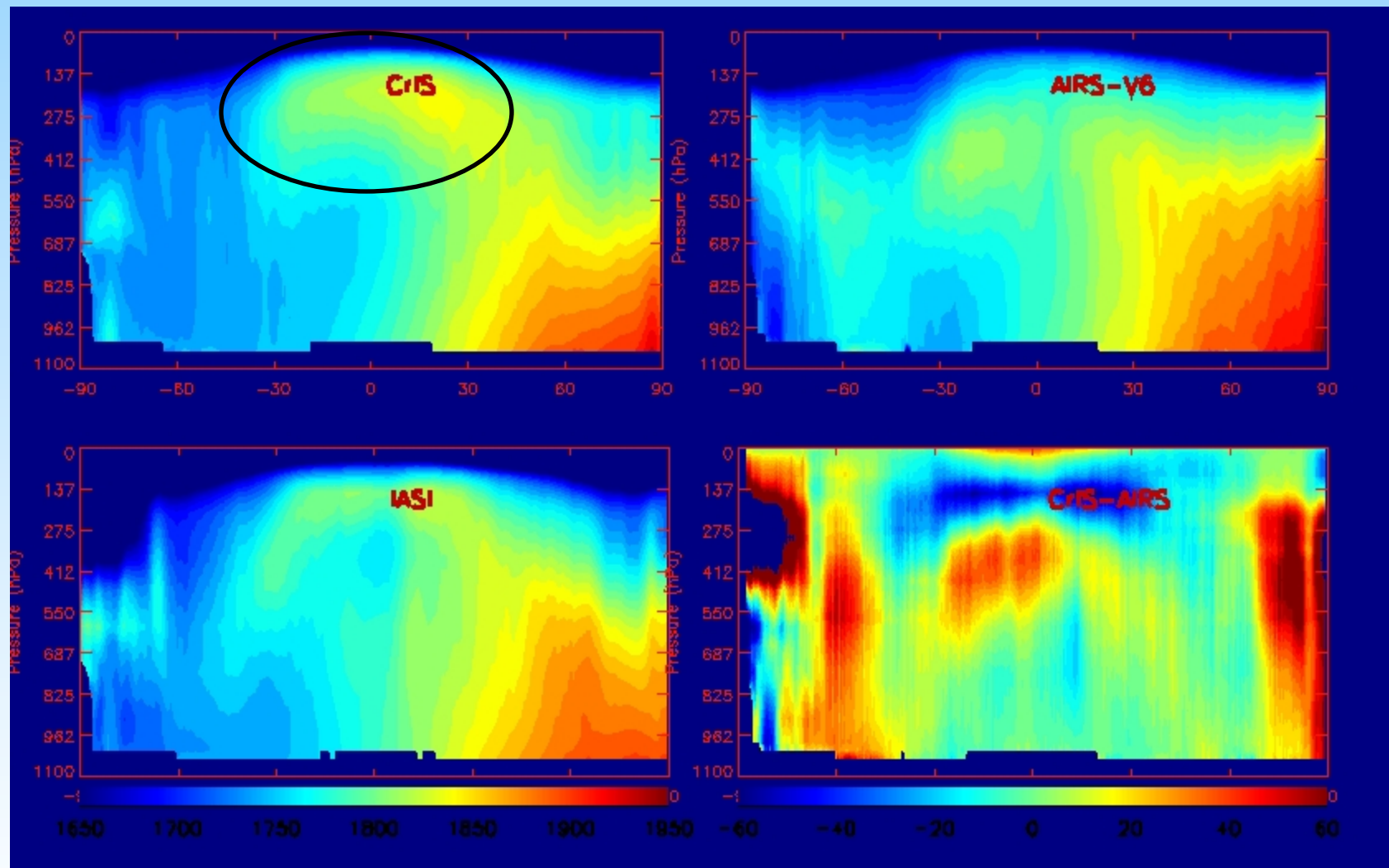
1800

1850

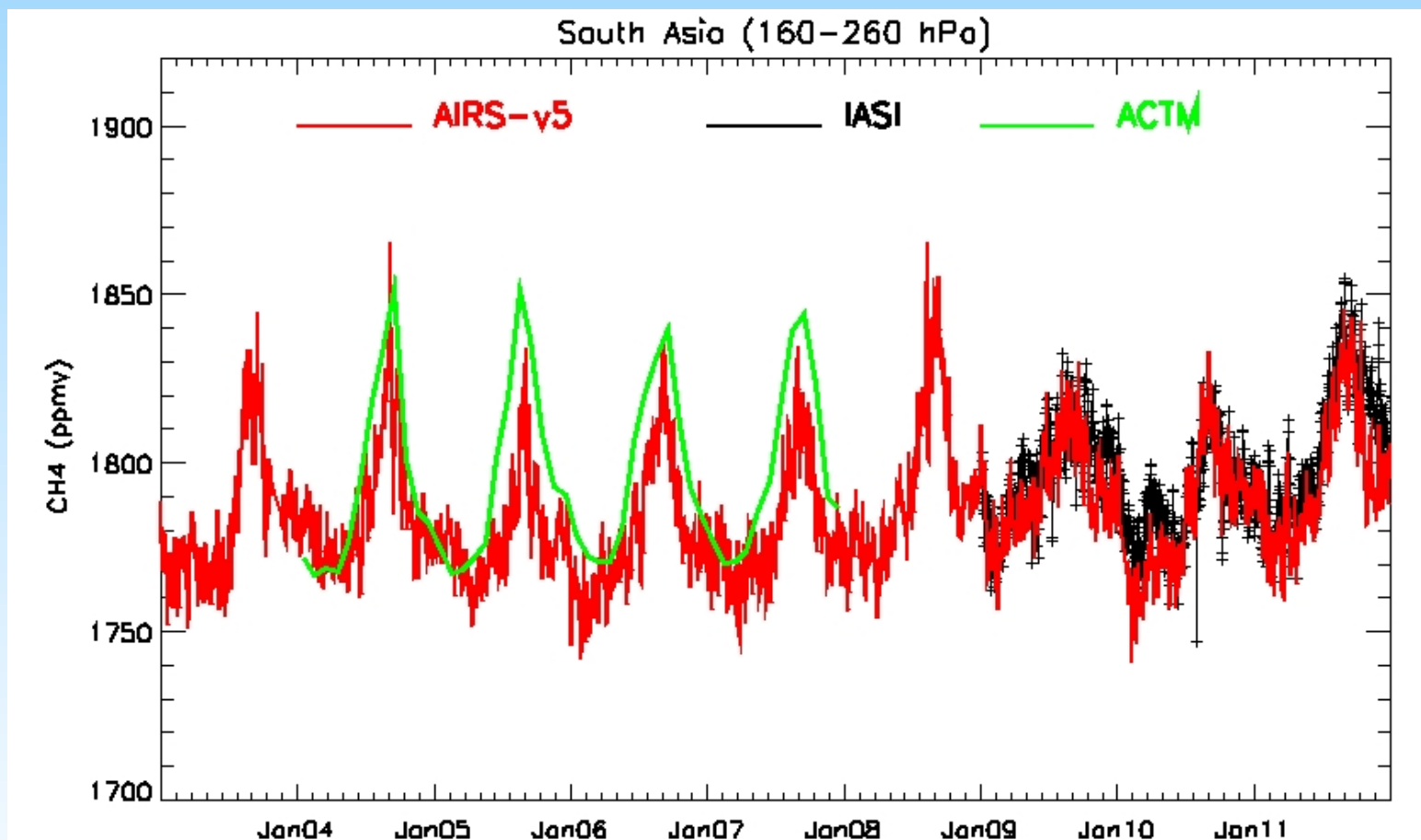
1900

ppbv

Mean Profiles in different latitude

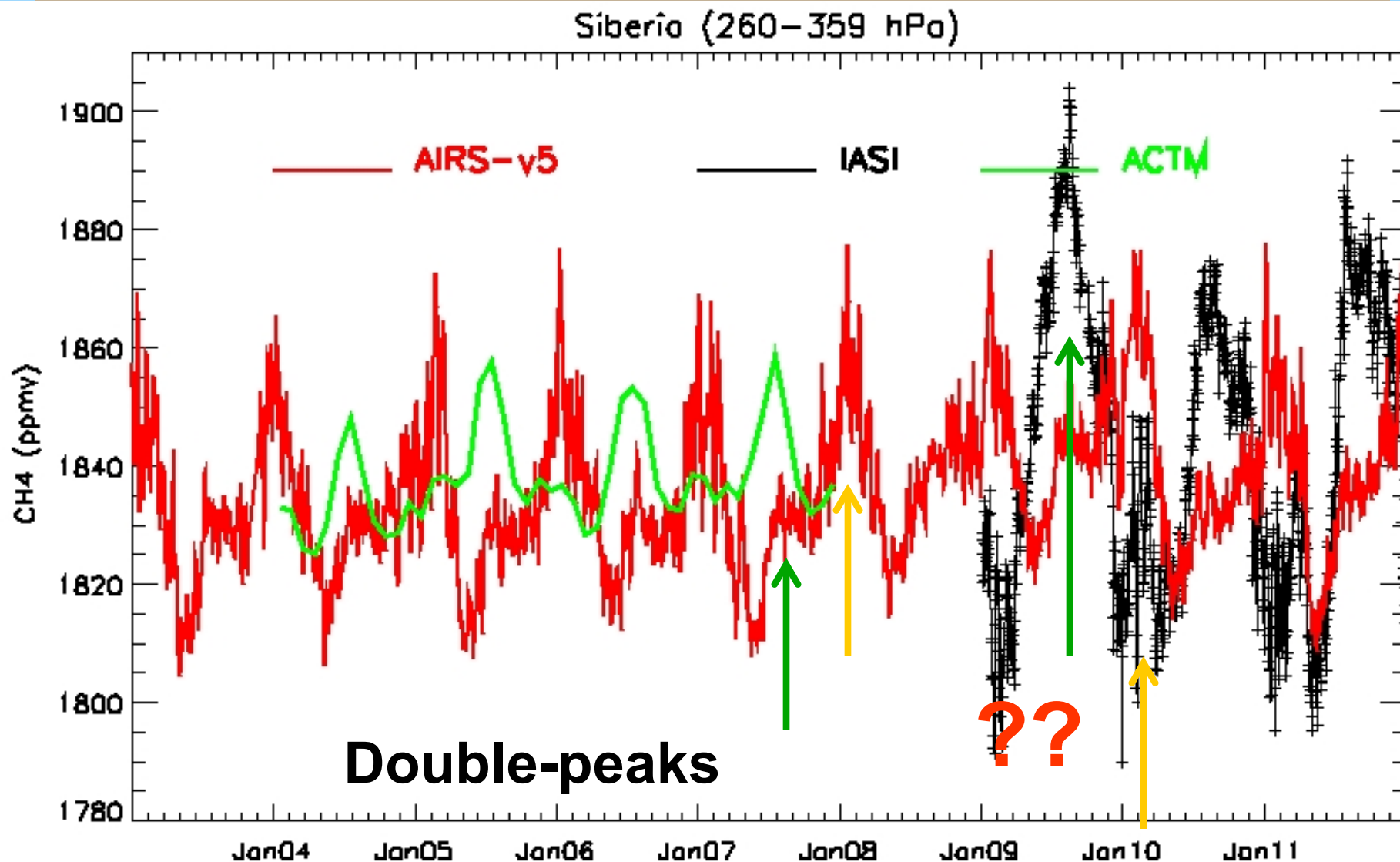


A very good agreement in observing the CH₄ enhancement over the south Asia



Xiong, X., et al, 2009, Methane Plume over South Asia during the Monsoon Season: Satellite Observation and Model Simulation, *Atmos. Chem. Phys.*, 9, 783-794, 2009 .

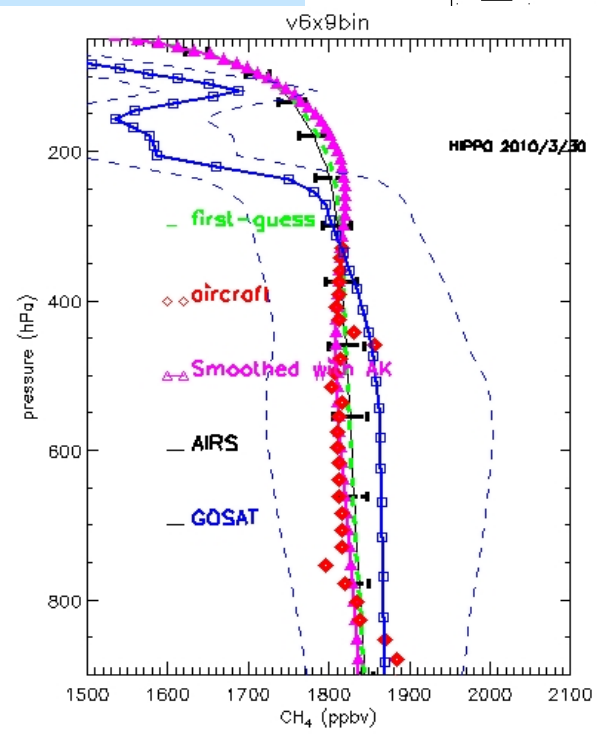
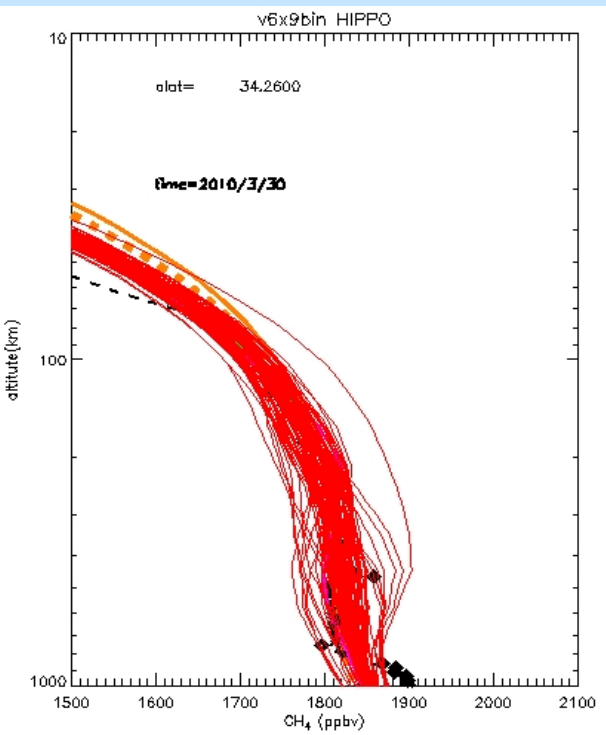
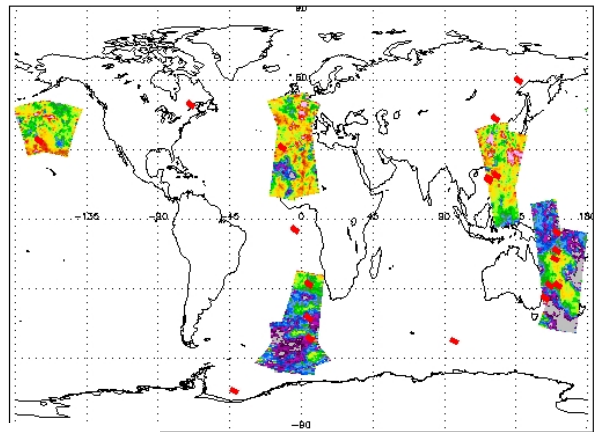
In Siberia, a much larger seasonal cycle from IASI than from AIRS-V5





Comparison of CH₄ retrieved from GOSAT TANSOTIR, AIRS and Aircraft Measurements

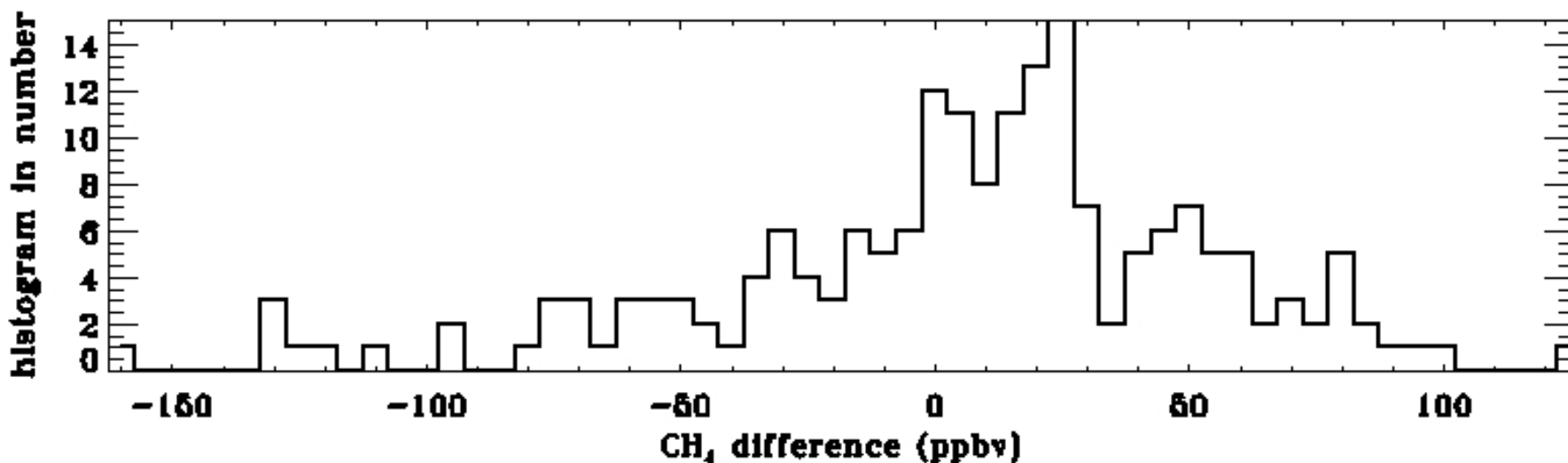
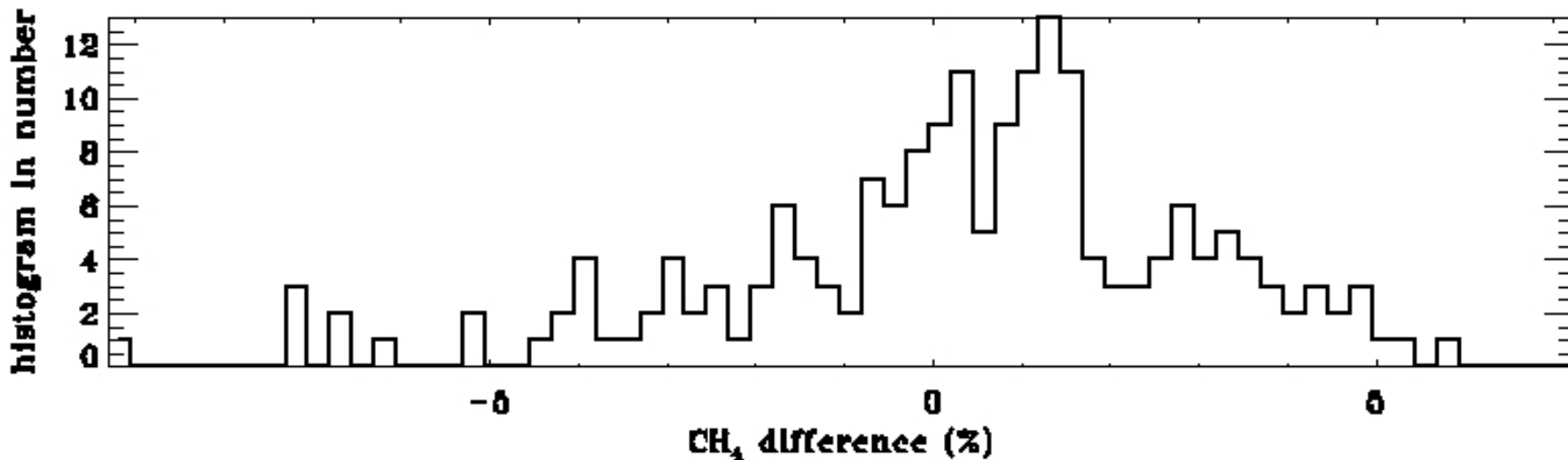
Xiaozhen (Shawn) Xiong
Chris Barnett(1),
Sachiko Hayashida(5),
Hidekazu Matsueda(7)
Evan Manning(8), T



20852, USA
Shiba University, Japan
radio, USA
Japan
Studies, Japan
te, Japan
adena, CA, USA

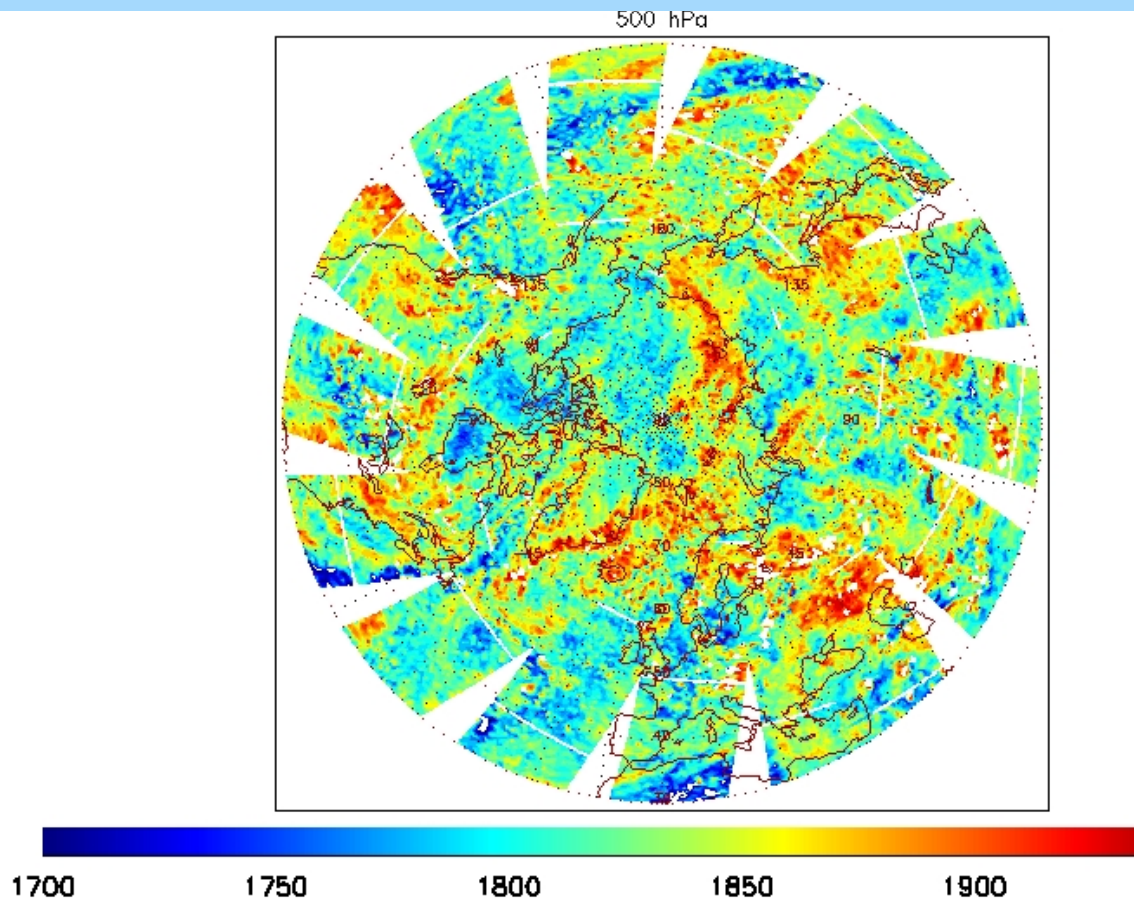
GOSAT-PI meeting

Histogram of GOSAT minus AIRS (300-500 hPa)





To generate a long-term record for monitoring the polar CH₄ emission under the impact of global warming



Multiple observations from AIRS per day over the polar regions

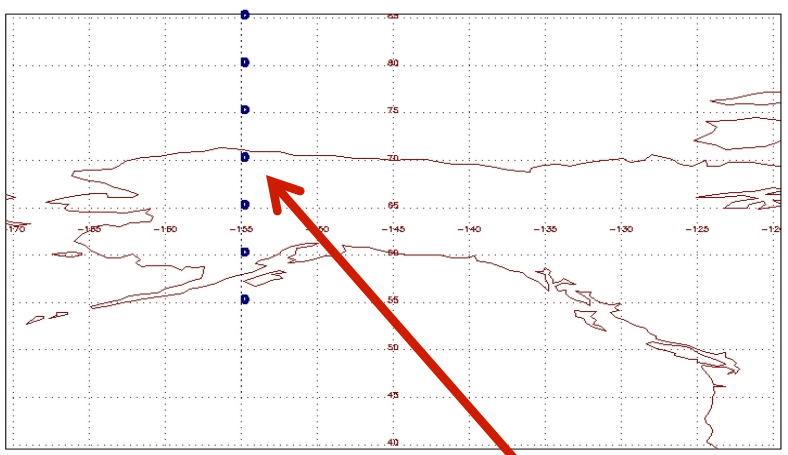
➤ Current algorithm is not optimized in the polar;

➤ Information of multiple observations per day has not been well used in L3 product;

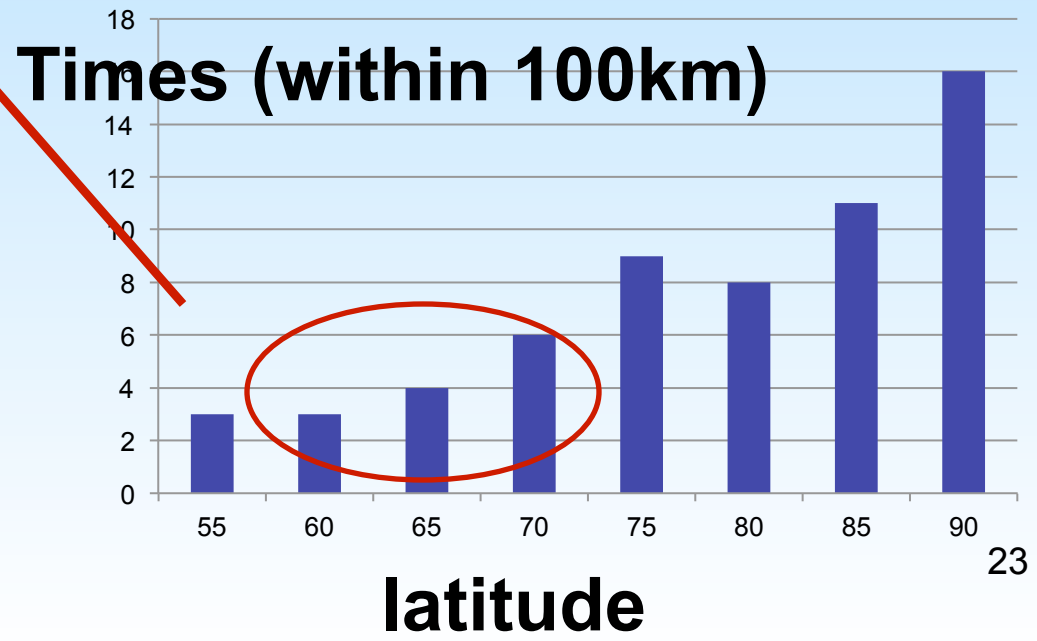
➤ We are investigating to better characterize the retrieval in the polar and use better first guess



CH4 Observations over Alaska

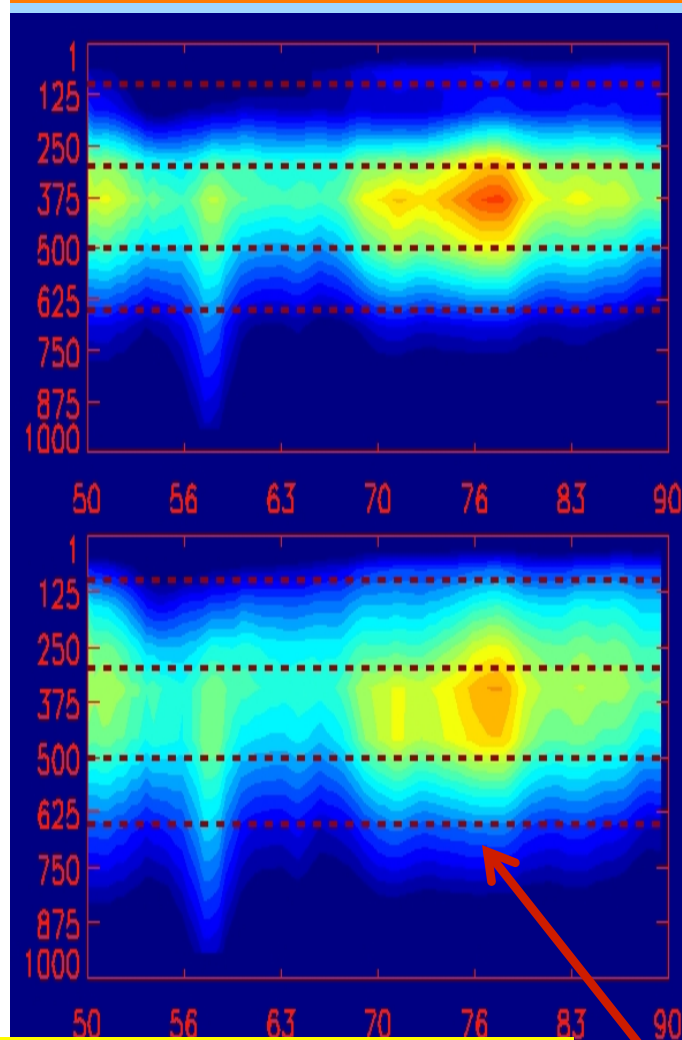
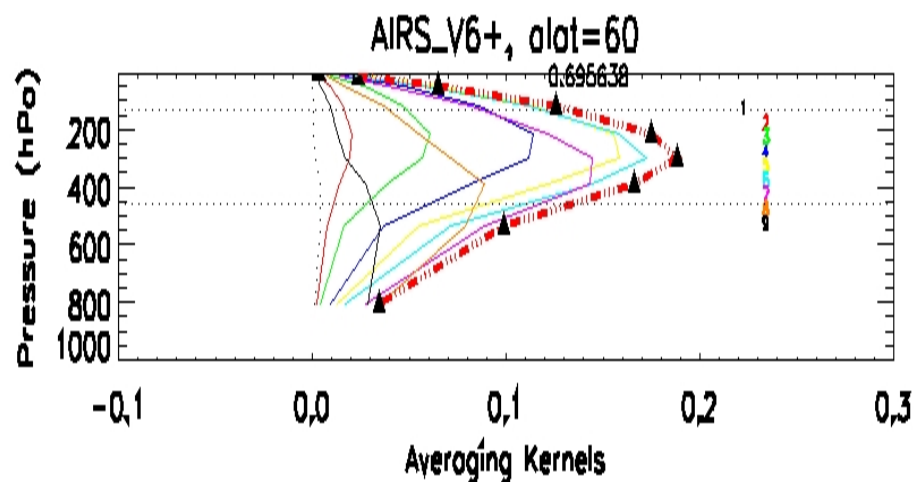
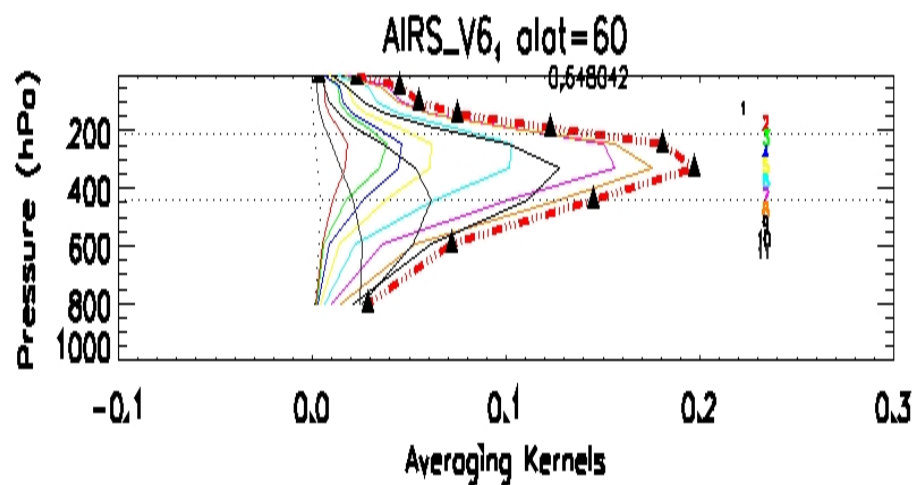


CH4 release from wetland and thawing permafrost are very sensitive to global warming. Its trigger will be a disaster.





Example: Optimization for the Polar CH₄ retrieval (2009/01/13)



Better sensitivity to lower troposphere

Summary (1/2)

- 1. Significant improvements in AIRS-V6 retrievals and setting of quality flag has been made, and the bias is within 0.5% and standard deviation less than 1%. More validation will be done as soon as all V6 data are available.**
- 2. Validation to NOAA CLASS IASI CH₄ product shows IASI is lower biased by ~1.7%. Recent improvement in AIRS-V6 will be incorporated in IASI CH₄ retrieval.**
- 3. CrIS has lower sensitivity and smaller DOF than AIRS and IASI. It is expected that better CH₄ product can be derived from the full spectral resolution CrIS data.**

Summary (2/2)

- AIRS and IASI CH₄ shows a **good agreement** in observing the seasonal cycle over the **south-Asia**, however, IASI observed a much larger summer increase in the polar region → which will be further analyzed using data from AIRS-V6.
- Comparison among AIRS, IASI and CrIS CH₄ products indicated that more works need to be done to generate a consistent, long-term CH₄ product for climate change study, and one effort we are focusing now is to derive a better product in the **polar regions**. This can become part of AIRS-v7.



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NOAA CLASS

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Hurricane Katrina
GOES 08/28/05

NEWS

Attention GOES Users:
GOES-13 has returned to operations as GOES-East on Thursday, October 18 at 1044 UTC. All operations are nominal. GOES-14 is now turned off. This leaves a gap of GOES-13 data between September 23 and October 18 in our database. When searching on GOES-East data in CLASS be sure to search on GOES-13 and GOES-14 to retrieve a complete inventory of files.

Suomi NPP data access status:
VIIRS RDR and SDR products along with CrIS SDR and RDR products are the latest products to be released to the public and can be ordered through CLASS. Please go to the [Suomi NPP FAQ](#) page to view the list of all products and dates ranges that are available. The remaining NPP products will be released to the user community over a time frame of several months.

Please note that all newly released products are at 'Beta' maturity level as defined in the [Product Maturity Level page](#). Details of high priority issues related to the data quality are contained in the Readme files provided by the NPP Project Scientist. All users are encouraged to read these before ordering and using the data. The following Readme files are provided

SEARCH FOR DATA

- Environmental Data from Polar-orbiting Satellites
- Environmental Data from Geostationary Satellites
- Defense Meteorological Satellite Program (DMSP)
- Suomi National Polar-orbiting Partnership (NPP)
- Sea Surface Temperature data (SST)
- RADARSAT
- Altimetry / Sea Surface Height Data (JASON-2)
- Global Navigation Satellite Systems (GNSS)
- Other - Miscellaneous products in CLASS

SEARCH COLLECTION METADATA
GO

www.class.ncdc.noaa.gov/index.html

11:29 AM 11/14/2012

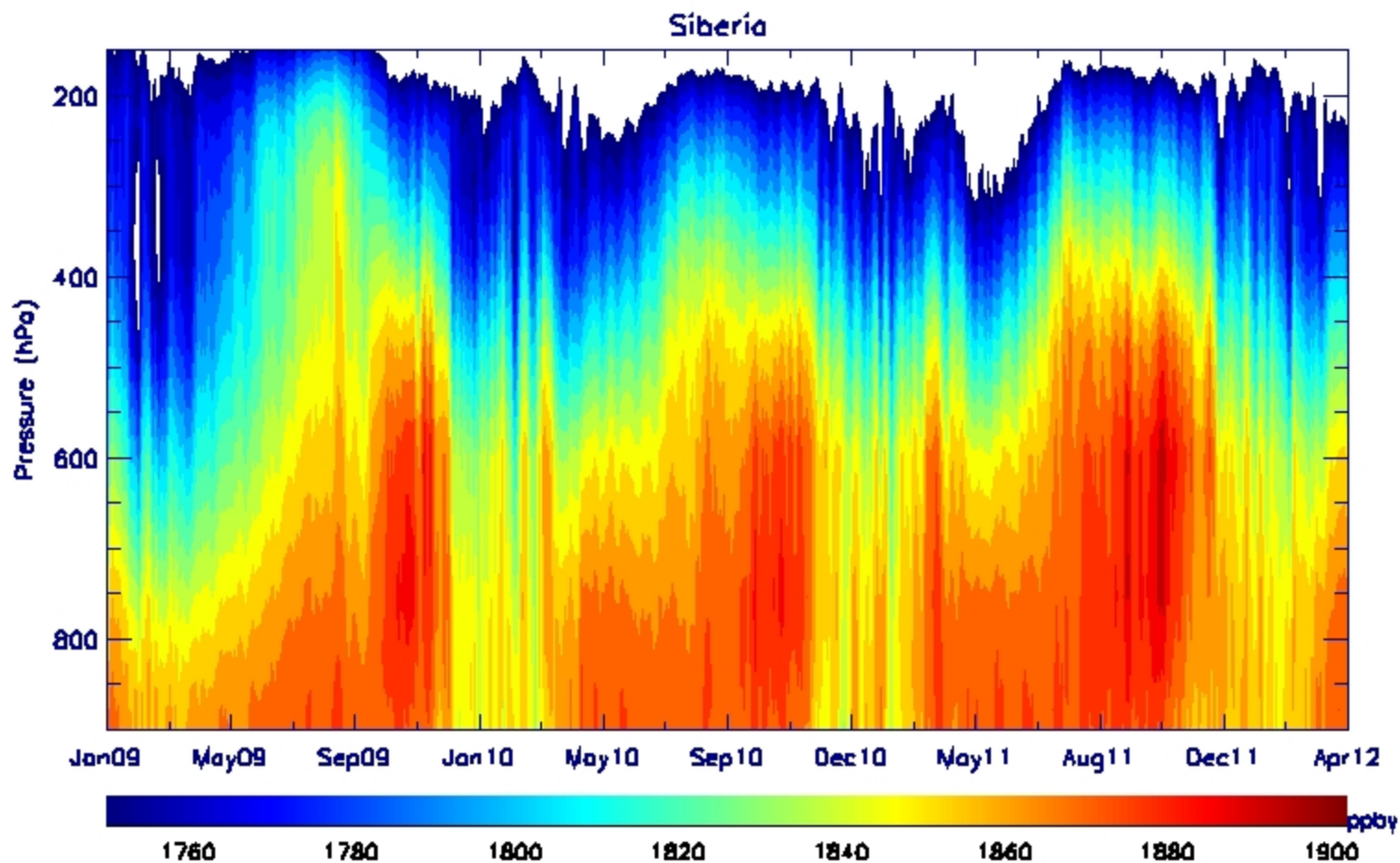
All these improvements in V6 are based on extensive validation

Aircraft measurements used include

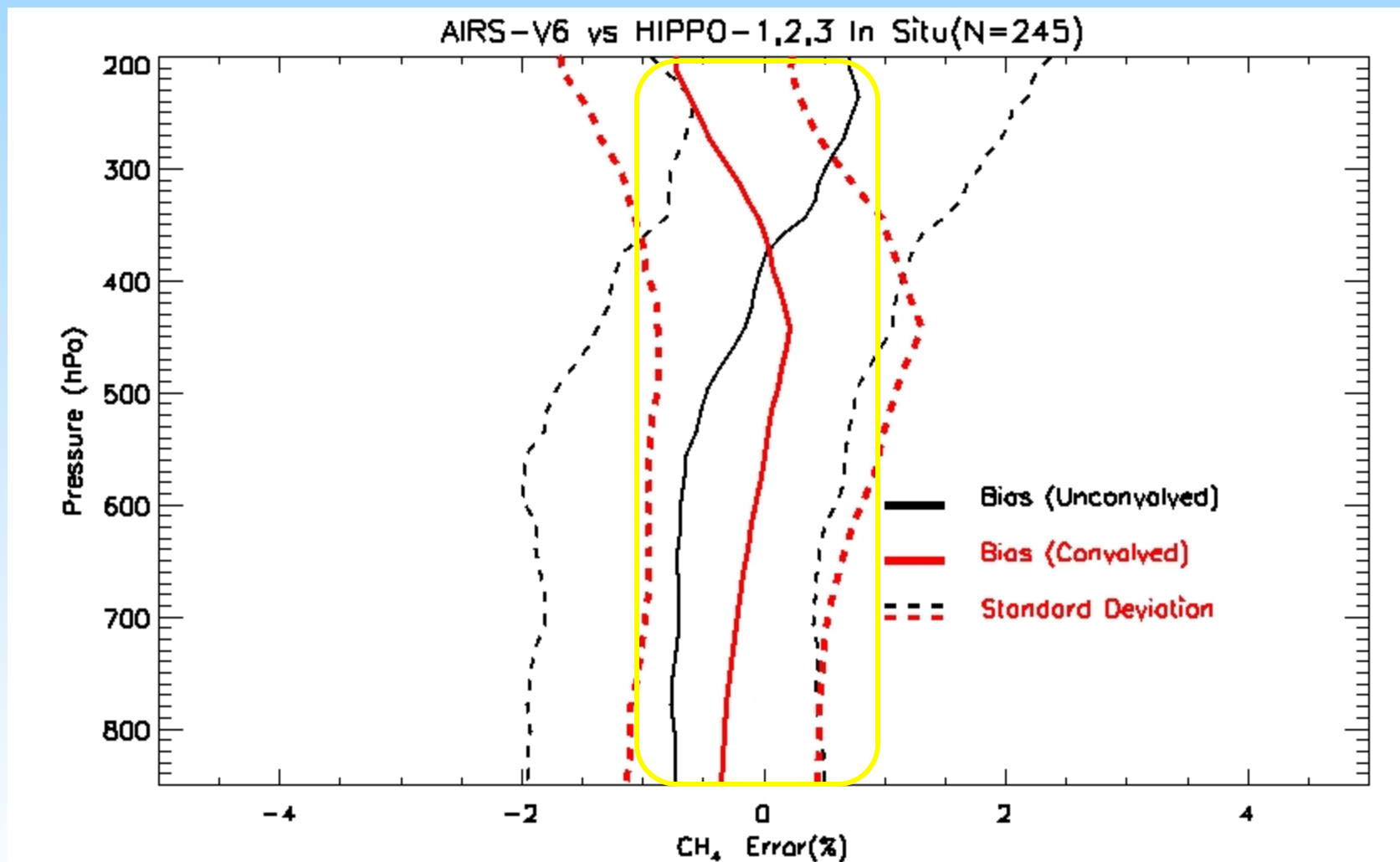
1. Aircrafts measurements from NOAA/ESRL/GMD
(the only one used for V5 optimization)
2. Intex-A (2004), -B(2006)
3. START08(2008)
4. ARCTAS(2008)
5. HIPPO-1, -2(2009), -3(2010)
HIPPO-4, -5 data have not been released to public



CH₄ over Siberia



Error of AIRS-V6 vs aircraft measurements



A paper about the setting of QC and validation is in preparation

Setting of QC

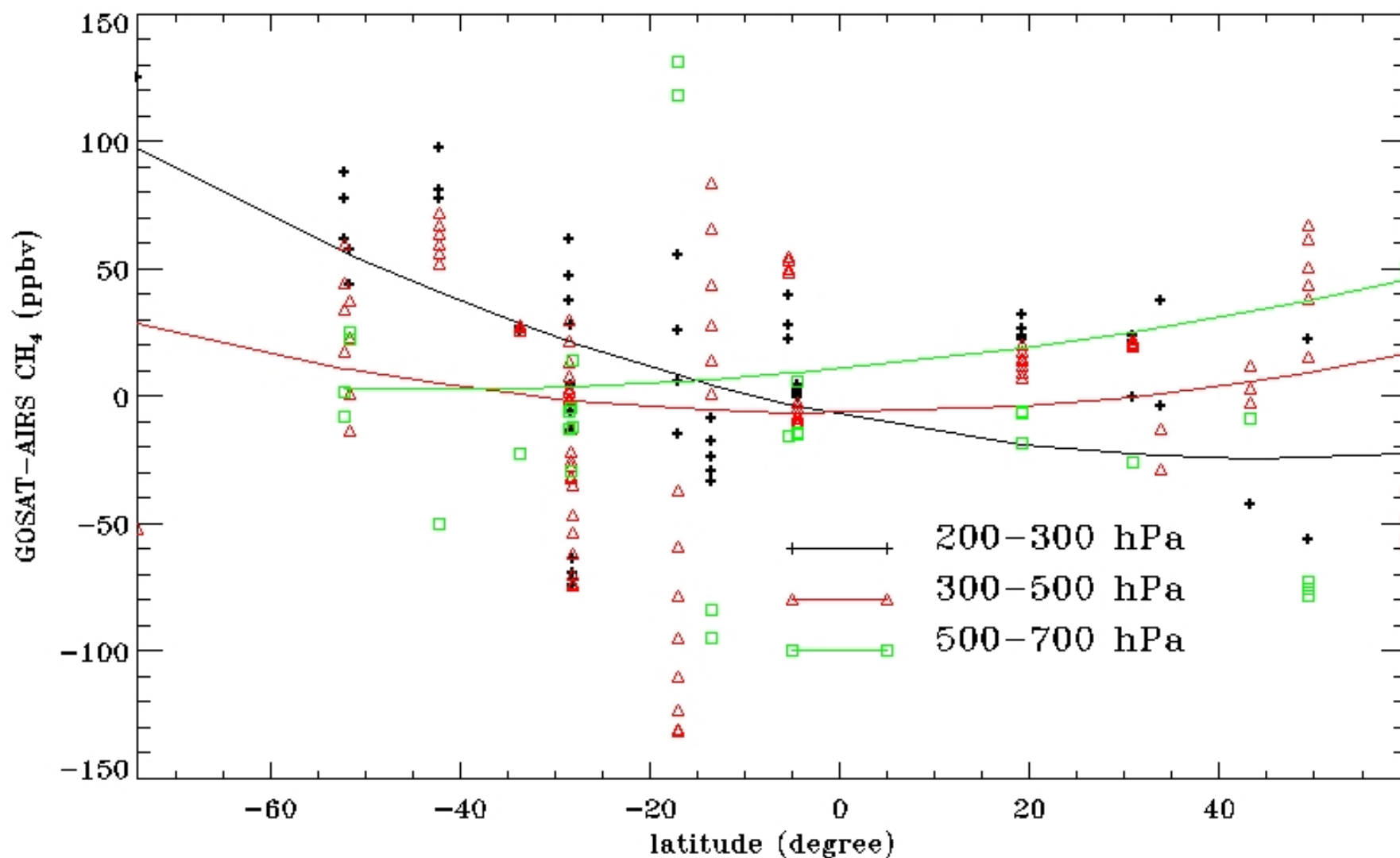
Both infrared and microwave retrievals of water vapor and temperature are successful;

Residual (observation minus RTA computation) relative to the estimated errors(including error in instrument, cloud-clearing, forward model) is less than 3 ($\text{Chi}^2 < 3$);

Total FOR Cloud fraction, solving for two layers of clouds, is less than 1.5 ;

DOF is greater than 0.3

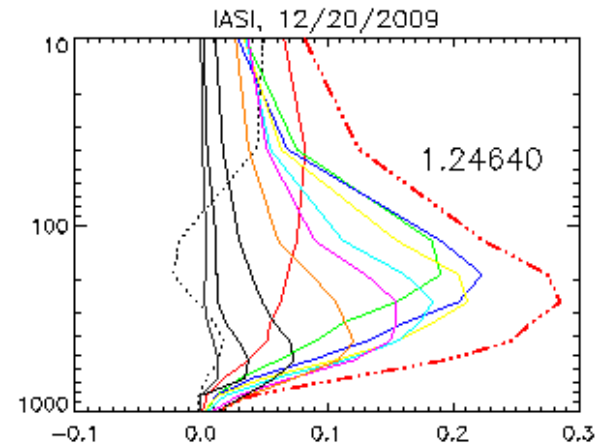
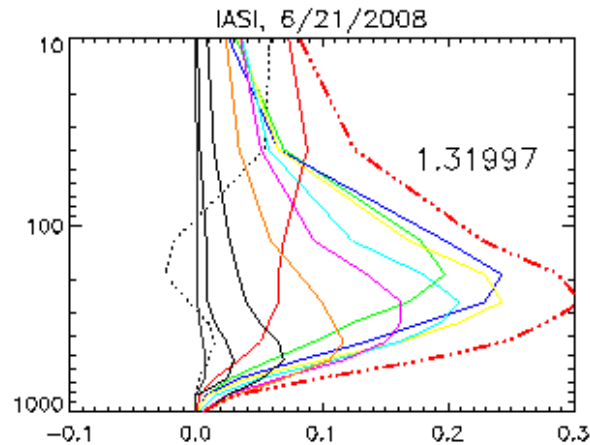
Comparison of AIRS vs GOSAT @ three layers



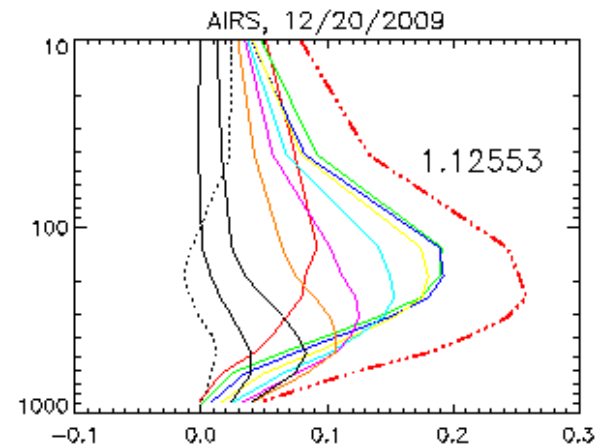
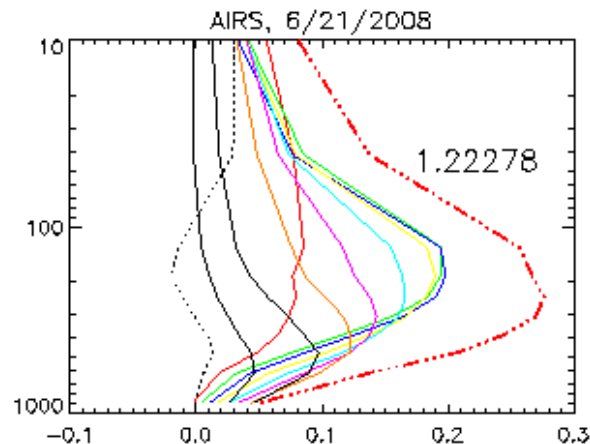


Comparison of Averaging Kernels (6/21/2008, 12/20/2009)

IASI →

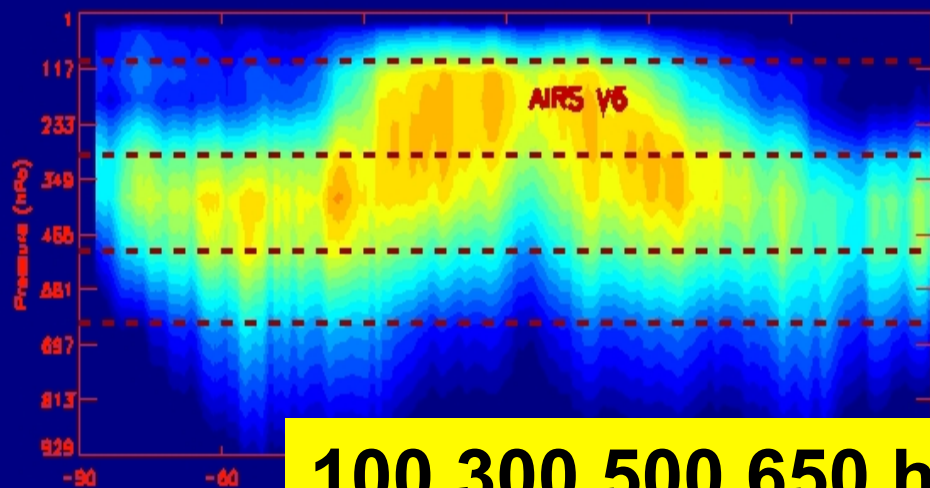
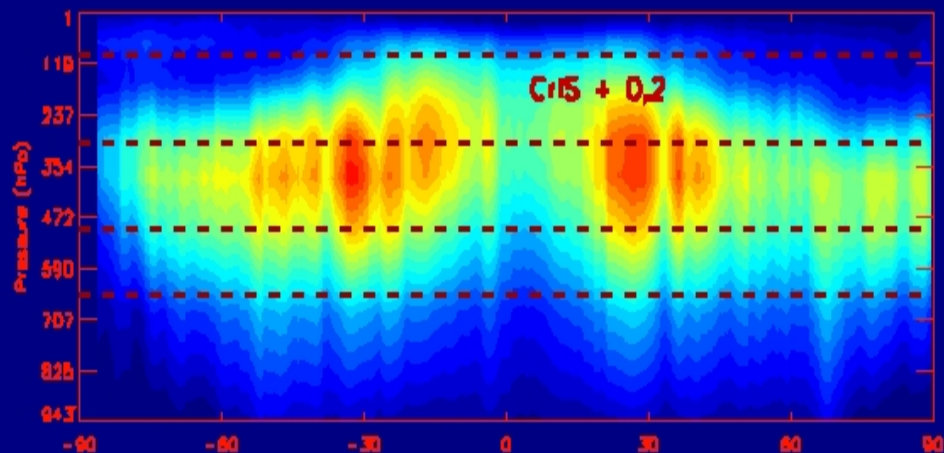


AIRS →

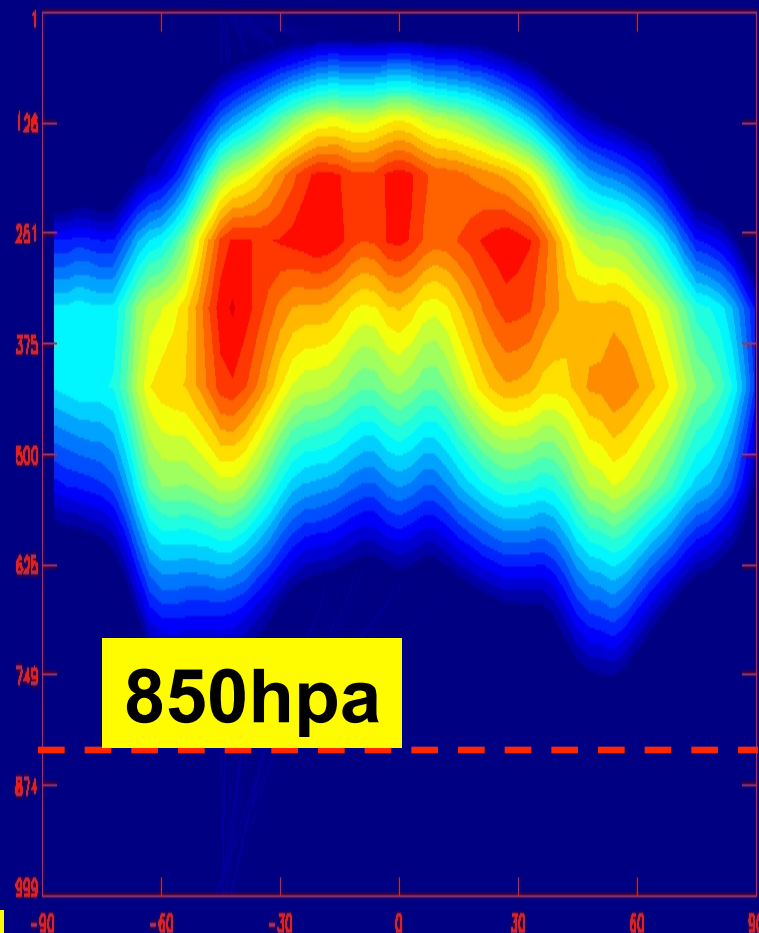




Area of Aveaging Kernels in different latitude



100,300,500,650 hPa



850hpa

5/15/2012

IASI (April, 2010)

Lower Bias in IASI, CrIS

